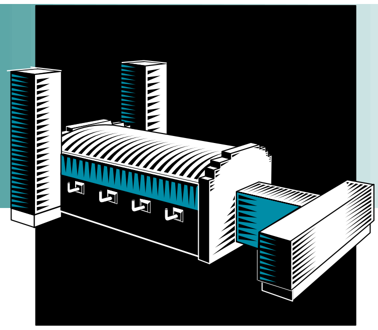
GLASS

Project Fact Sheet



Development and Validation of a Coupled Combustion Space/Glass Bath Furnace Simulation

Benefits

- Optimization of melter operation and combustion process, yielding improved production efficiency and reduced costs and emissions
- A modeling capability that can aid in problem solving and facilitate more rapid design and introduction of new products
- Accessibility to modeling tools for manufacturers throughout the industry without the expense of maintaining in-house modeling capabilities

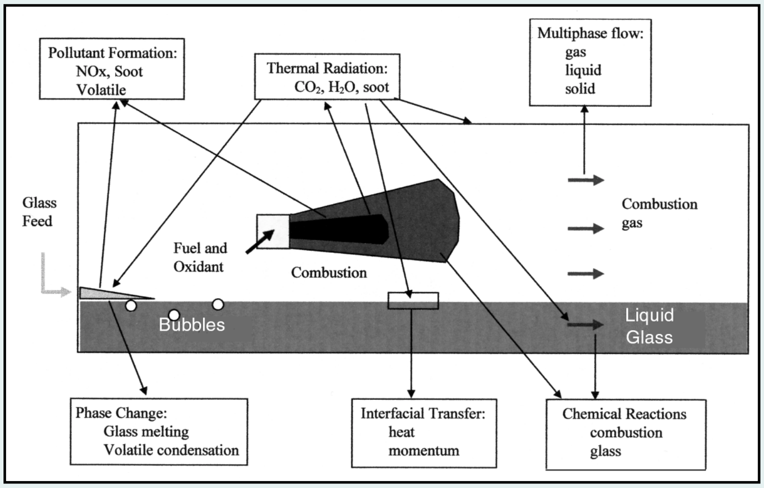
Applications

The project will offer the industry a validated, analytical tool that can be used to evaluate new furnace designs, evaluate furnace performance, develop optimal fuel-firing strategies, and devise methods to improve cost efficiency and environmental performance. Since the model is being developed collaboratively with industry partners that already employ modeling capabilities, the development and validation of this coupled model will result in immediate application.

Glass furnace simulation model will improve energy use and efficiency while reducing emissions

Competitive and regulatory pressures are motivating glass manufacturers to seek new ways to improve productivity while reducing furnace energy use and emissions. The pursuit of these goals, however, often leads to conflicting requirements for the design and operation parameters of glass melting furnaces. To surmount these conflicting requirements, a robust, validated, computational model of glass melting furnaces is being developed. Although three-dimensional computer models of the individual components of the melting system do exist, they have not been coupled into an entire furnace model. One innovative feature of this proposed model is that the newly developed code will directly couple the combustion space with the glass batch/melt through a rigorous spectral radiation model that computes radiant transfer throughout the whole furnace volume, allowing for spectral radiation from combustion species such as H_20 and $C0_2$ and radiation to and from the crown and glass melt, thus producing a more accurate model of the entire system. This accurate modeling tool will lead to optimization of existing melter operation, which in turn will improve production efficiency and quality while reducing operating costs and emissions.

Process Schematic for Operation of a Glass Melting Furnace



New model will couple and simulate all components of a glass melting furnace.

Project Description

Goal: Develop, validate, and apply an innovative, three-dimensional, glass melting furnace simulation model that provides a more accurate representation of the entire melting process by coupling the combustion space with the glass batch and the glass bath.

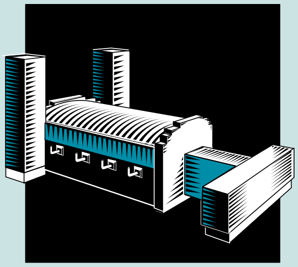
Argonne National Laboratory will develop the combustion space model; Purdue University will assist ANL in developing the glass bath model. The two models, together with a detailed glass batch model, will be synthesized into one code by ANL and validated against existing industrial furnace measurements as well as data from a measurement program conducted on an operating furnace. Once validated, the simulation will be available to be used to optimize furnace performance with regard to energy use, emissions, and productivity.

Progress and Milestones

The principal milestones of Part I of the two-part program have been achieved. A CFD based combustion space model that incorporates a rigorous treatment of spectral radiation heat transfer throughout the whole furnace volume, to and from the crown, glass melt and glass batch, has been developed. The glass melt has been modeled with ANL's multiphase reacting flow code, directly incorporating a model of the glass batch. The combustion space and glass melt models have been coupled into an overall furnace model and used to develop a simulation of a Techneglas furnace. Initial measurements of key performance parameters in the furnace modeled have been made. An initial complete data set has been acquired and used to validate the furnace model. Electric boost and bubbler models are being developed and will be incorporated into the furnace code.

Key technical objectives for the Part II follow-on program are to: (1) incorporate glass chemistry models into the glass melt and to compute and track key solid, gas, and liquid species throughout the melt; (2) activate the gaseous phase transport equations built into the glass melt model with source terms derived from the chemistry models to compute gaseous species production, bubble nucleation and growth, dissolution, and release from the glass melt surface (foaming); (3) develop and incorporate chemistry and nucleation models of space; and (4) develop and incorporate glass quality indices into the simulation to facilitate optimization studies with regard to productivity, energy use, and emissions, (5) develop and validate furnace simulations of three additional furnace types used in the industry, (6) conduct a workshop for the entire industry at the conclusion of the program where the code, furnace simulation and all data and information derived from the program will be made available to all.

Establishment of a user center: At the conclusion of the project a user center will be established at Argonne National Laboratory that will be available to any organization in the glass industry interested in using the validated model to analyze its furnaces.



Project Partners

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December 2000